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The Longitudinal Relationships Between Basic Psychological Needs Satisfaction at School and School-Related Subjective Well-Being in Adolescents

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Abstract Situated within a positive psychology perspective, this study aimed at examining the nature and directionality of longitudinal relationships between basic psychological needs satisfaction at school and adolescents' school-related subjective well-being. A total of 576 students (40.5 male and 36.8 % students in junior high school) completed measures of adolescent students' basic psychological needs at school and school-related subjective well-being at two time points, 6 weeks apart. Cross-lagged structural equation modeling showed significant bidirectional longitudinal relationships between autonomy, relatedness, and competence needs satisfaction and school satisfaction. Furthermore, significant bidirectional relationships were observed between competence need satisfaction and positive affect in school. The findings provided important evidence of the roles of adolescents' different types of needs satisfaction, experienced specifically during school, in adolescents' school-related subjective well-being. The findings also helped extend the positive psychology perspective to the relatively neglected context of education.

Keywords Basic psychological needs satisfaction at school · School-related subjective well-being · Adolescents · Longitudinal

1 Introduction

Adolescents' subjective evaluations and experiences in school significantly relate to their overall life quality (Huebner and Gilman 2006). What determines whether adolescents

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positively evaluate and experience their school lives, specifically their school-related subjective well-being? Research on self-determination theory (SDT; Ryan and Deci 2000) has shown the importance of basic psychological needs satisfaction for general subjective well-being (e.g., Eryilmaz 2012). However, few studies have examined the influence of basic psychological needs satisfaction *at school* on adolescents' *school-related* subjective well-being. Additionally, numerous studies have shown that school-related subjective well-being is not only important in and of itself, it also influences important adaptive outcomes, such as academic achievement, students' behaviors in school, and basic psychological needs satisfaction at school (Elmore 2007; Huebner and Gilman 2006). Guay et al. (2008) pointed out, "educational studies using cross-lagged longitudinal data are less frequent and by conducting such studies, we could more accurately test the direction of causality amongst variables" (p. 237). The present study thus seeks to add to the existing literature on self-determination theory and school-related subjective well-being by first examining whether adolescents' basic psychological needs satisfaction at school is related to the specific domain of school-related subjective well-being. If so, the present study also seeks to determine the directionality of the relationships between adolescents' basic psychological needs satisfaction at school and their school-related subjective well-being.

1.1 Basic Psychological Needs

Self-determination theory has identified three basic psychological needs for optimal psychological growth and well-being: autonomy, relatedness, and competence (Deci and Ryan 2000). According to SDT, the need for autonomy refers to feeling a sense of volition and endorsement in one's behavior. The need for relatedness refers to situations in which individuals feel that they are authentically associated with significant others and they experience a sense of belonging. The need for competence refers to the need to interact effectively with one's environment and to experience opportunities for expressing or developing one's capacities (Deci and Ryan 2000). Self-determination theory states that each of these three basic psychological needs is essential because each need provides distinct "psychological nutriments" that sustains well-being (Ryan 1995, p. 410), and all contribute independently to healthy psychological growth (Ryan and Deci 2000). A growing body of research based on both the SDT conceptualization of psychological needs as well as other perspectives has provided evidence for the role of each of these needs in psychological health and well-being (Carver and Scheier 2000; Deci and Ryan 2000; Kernis 2000; Reis et al. 2000). Put differently, these three needs have been found to have empirically distinguishable effects. Additionally, these needs are thought to be universal across people and cultures and applicable throughout all aspects of a person's life. Individuals are likely to thrive and be motivated in settings that fit well with their psychological needs (Deci and Ryan 2000; Eccles and Roeser 2011). On the other hand, a failure to meet these needs increases the risk of pathologies and leads to more illnesses (Ryan and Deci 2000; Sheldon and Bettencourt 2002).

1.2 Basic Psychological Needs and Well-Being

Many studies with adults have demonstrated that satisfaction of the three basic psychological needs is directly associated with well-being and that each need contributes uniquely to well-being, both in general and specific contexts. General needs satisfaction has been shown to predict general subjective well-being. For example, Sheldon and Elliot (1999) assessed college students' reports of their subjective well-being and basic psychological

needs satisfaction at the beginning of a semester, along with their reports of needs satisfaction on three occasions during the semester, and their reports of subjective well-being again at the end of the semester. Using a structural equation model, the authors observed that basic psychological needs satisfaction at Time 1 predicted the students' subjective well-being at the same time point. They also found that needs satisfaction during the semester mediated the relationship between Time 1 subjective well-being and Time 2 subjective well-being, with the path from Time 1 subjective well-being to semester need satisfaction suggesting that Time 1 subjective well-being might itself be an important predictor of later positive outcomes. Domain-specific needs fulfillment has also been linked to domain-specific well-being including positive emotions and satisfaction in sports (Gagné et al. 2003), work well-being (Baard et al. 2004; Vansteenkiste et al. 2007), involvement in volunteer work (Gagné 2003), and relationship satisfaction (Patrick et al. 2007), among others.

Throughout the literature, research on the basic psychological needs satisfaction of adolescents has lagged significantly behind that of adults (Eryilmaz 2012; Leversen et al. 2012; Véronneau et al. 2005). During adolescence, individuals have a growing need for autonomy, relatedness and competence. However, a mismatch may arise between the needs of developing adolescents and the opportunities afforded by their social environments, such as the school environment. According to the stage-environment fit perspective, this mismatch would reduce adolescents' subjective well-being (Eccles et al. 1993). Therefore, it should be useful to study the relationship between needs satisfaction and subjective well-being within important, specific domains of adolescent life for improving adolescents' well-being.

A growing body of studies has recently revealed that basic psychological needs satisfaction is associated with general subjective well-being in adolescence (Eryilmaz 2012; Véronneau et al. 2005). However, most of these studies examined general rather than domain-specific subjective well-being (Milyavskaya and Koestner 2011). As Sarason (1997) summarized, "Subjective well-being judgments always occur within environmental contexts, such as relationships, family and school" (p. x). Thus it may be illuminating to explore the relationships between basic psychological needs satisfaction and domain-specific aspects of subjective well-being. Given that adolescents spend more time in school than in any other context (Roeser et al. 2000) and that school plays an important role in facilitating or inhibiting successful adolescent development (Cartland et al. 2003; Schaps and Solomon 2003), it may be beneficial to examine the satisfaction of their basic psychological needs during school time in relation to their judgments of their subjective well-being in school. However, the few existing studies linking basic psychological needs satisfaction to school-related variables, have mainly focused on the importance of basic psychological needs satisfaction to achievement-related outcomes, such as student engagement (e.g., Connell and Wellborn 1991), academic achievement (e.g., Ratelle et al. 2007) and persistence in school (e.g., Ratelle et al. 2005). Considerably less attention has been paid to investigating the relationships between basic psychological needs satisfaction at school and psychosocial outcomes of schooling.

1.3 School-Related Subjective Well-Being

Current research on well-being has been derived from two general perspectives. The first one, the eudaemonic approach, as represented by psychological well-being, focuses on meaning and self-realization and defines well-being in terms of the degree to which a person is fully functioning and engaged (e.g., experiencing personal growth and

development) (Waterman 1993). The second is the hedonic approach, as represented by subjective well-being, which focuses on happiness and defines well-being in terms of all judgments about the good/bad elements of life (Diener et al. 1998). Adolescents' psychological well-being within school setting has been investigated. For example, Fernandes et al. (2011) found that satisfaction with school context positively correlated with all dimensions of psychological well-being. Correspondingly, subjective well-being is also an indispensable perspective to study adolescents' school well-being, the present study thus intended to investigate adolescents' school well-being from the subjective well-being perspective. Grounded in the theoretical and empirical literature on subjective well-being (Diener 1994), Tian (2008) has specifically conceptualized school-related subjective well-being as how students subjectively evaluate and emotionally experience their school lives. Furthermore, she has proposed a tripartite model, in which school-related subjective well-being consists of school satisfaction, positive affect in school, and negative affect in school. School satisfaction refers to a student's subjective, cognitive evaluation of school life using her or his own standards related to several specific school life domains (e.g., academic learning, teacher-student relationships). Positive affect in school refers to a student's positive emotions experienced during school, such as feeling relaxed, pleasant, or happy. Negative affect in school refers to a student's negative emotions experienced during school, such as feeling depressed, upset, or bored.

School satisfaction, as a major component of school-related subjective well-being, has previously received attention from scholars (e.g., Baker et al. 2003; Huebner et al. 2001). Connell and Wellborn (1991) suggested that students' evaluations of their school experiences reflected, in a sense, the extent to which school experiences satisfied basic psychological needs, including needs for competence, autonomy, and relatedness. Studies have demonstrated the importance of student involvement in decision making (Epstein 1981), supportive teacher and peer behavior (Tian et al. 2013b), and academic competence and social acceptance (Tian and Liu 2007) to school satisfaction and well-being. The findings suggest that three basic psychological needs satisfaction at school may thus promote adolescents' school-related subjective well-being.

Although researchers often regard school-related subjective well-being as an outcome variable, recent empirical studies have shown that school-related subjective well-being can be an antecedent or causal factor in determining important outcomes as well. For example, Elmore (2007) found that adolescents' satisfaction with their school experiences may contribute to feelings of belonging, autonomy and competence necessary for self-system processes and provide a "protected space of psychological functioning" for some youth (Connell 1990; Roeser et al. 2001, p. 133). Additionally, studies have also demonstrated that students with high levels of school satisfaction reported a greater frequency of participation in structured extracurricular activities, higher school grades, and more positive perceptions of teachers (Huebner and Gilman 2006). However, the vast majority of the research has been cross-sectional in nature, which precludes determining the directionality of the relationship between basic psychological needs satisfaction at school and school-related subjective well-being. Thus, for example, it is unclear whether positive interpersonal relationships influence school satisfaction or vice versa. To clarify the directionality of the relationship between basic psychological needs satisfaction at school and school-related subjective well-being, longitudinal studies are necessary. However, such studies are scarce and only two studies have examined the relationships between needs satisfaction and well-being. In a longitudinal study with a sample of 272 Spanish university students on basic psychological needs and well-being, León and Núñez (2012) found that needs of competence and relatedness influenced subsequent well-being, well-being did not influence

subsequent competence and relatedness needs. However, they used subjective vitality, self-esteem, and satisfaction with life, as their indicators of well-being, which are not specific to the subjective experience in the school context. Additionally, one recent longitudinal study with Austrian secondary school students' concluded that school experiences (i.e., a summary measure of satisfaction of autonomy, relatedness, and competence needs) and positive affect (i.e., frequency of positive emotions) influenced each other across time. Although this study represented an important contribution to understanding adolescents' needs satisfaction at school and subjective well-being, it used positive affect as the exclusive indicator of well-being, neglecting negative affect and cognitive evaluation of school life. Furthermore, the items on the positive affect measure asked the students to report on their emotions experienced in general, not specifically during school hours. Finally, the findings did not address the question of which specific positive school experiences (i.e., specific needs satisfaction) are more or less important in this process (Stiglbauer et al. 2013). Our research thus extends the findings of these studies by investigating further the linkages between specific psychological needs satisfaction (autonomy, relatedness, competence) at school and *multiple* domains of school-related subjective well-being (school satisfaction, positive affect in school, negative affect in school).

1.4 Purpose of Current Study

This study examined the nature and directionality of longitudinal relationships between basic psychological needs satisfaction at school and adolescents' domain-specific, school-related subjective well-being. Specifically, we formulated two hypotheses: (a) Based on SDT and previous research, each of the three needs was described as a basic and yet distinct psychological nutriment, we thus treated autonomy, competence, and relatedness as separate constructs, and hypothesized that each of the three types of adolescents' basic psychological need satisfaction at school at Time 1 would independently predict increases in students' school-related subjective well-being indicators at Time 2. (b) According to Fredrickson's (2001) Broaden-and-Build Theory of Positive Emotions, positive emotions (e.g., joy, interest, or contentment) broaden the scope of attention, cognition, and action and thus build physical, intellectual and social resources over time. Thus, we also hypothesized that school-related subjective well-being indicators at Time 1 would predict increases in adolescents' satisfaction of all three basic psychological needs at school at Time 2. Furthermore, if both hypotheses were supported, there would be evidence for bidirectional relationships between basic psychological needs satisfaction at school and school-related subjective well-being. In order to test these hypotheses, a model of bidirectional relationships between the three basic psychological needs satisfactions at school and school-related subjective well-being variables was evaluated. Figure 1 shows the overall hypothesized model.

2 Method

2.1 Participants

At the beginning of the second semester in 2011–2012, a total of 654 students from different schools in a mid-sized city located in a Southern China province completed questionnaires administered by school staff. Of the 654 students, 576 students completed questionnaires 6 weeks later. At Time 1, the mean participants' age was 15.69 (SD = 1.65). At Time 2, the

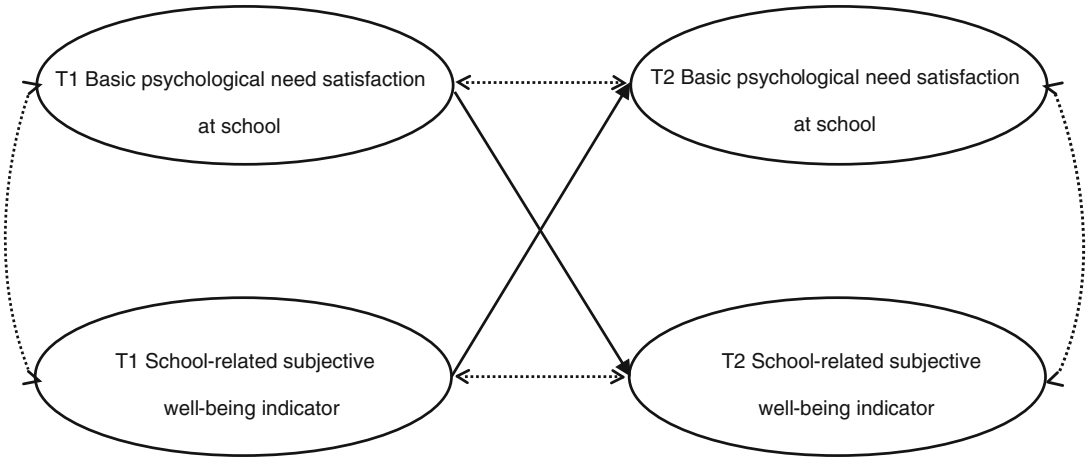

Fig. 1 Hypothesized relationships between basic psychological need satisfaction at school and school-related subjective well-being indicator. *Solid lines* indicate hypothesized relationships. *Dotted lines* indicate variables are allowed to covary. Controlled covariates are not diagrammed in the figure. T1 = Time 1, T2 = Time 2

mean age was 15.57 (SD = 1.65). Of the participants, 41.6 % were male and 58.4 % were female at Time 1 and 40.5 % male and 59.5 % female at Time 2. Based on Time 1, 38.5 % of students were in junior high school and 61.5 % of students were in senior high school, and at Time 2, 36.8 % of students were in junior high school and 63.2 % of students were in senior high school.

2.2 Measures

2.2.1 Adolescents' School-Related Subjective Well-Being

Adolescents' school-related subjective well-being was measured using the Adolescents' Subjective Well-Being in School Scale (ASWBSS: Tian 2008). It is a 50-item self-report scale comprised of three subscales: (a) School Satisfaction (b) Positive Affect in School, and (c) Negative Affect in School. The School Satisfaction portion consists of 36 items (e.g., "The school has high teaching quality"). Responses were made on a 6-point scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). The Positive Affect in School portion consists of seven adjectives describing positive emotions experienced during school (e.g., exciting, happy, and relaxed). Responses were made on a 6-point scale, ranging from 1 (never) to 6 (always). The Negative Affect in School portion is composed of seven adjectives describing negative emotions experienced during school (e.g., depressed, upset, and bored). Responses were made on a 6-point scale, ranging from 1 (never) to 6 (always). Previous research has shown that the internal consistency reliabilities of school satisfaction, positive affect in school and negative affect in school subscales were 0.94, 0.86 and 0.85 respectively, the one-month retest reliabilities were 0.75, 0.67 and 0.72 respectively, and the subscales have good construct validity (Tian and Liu 2007). In this study, the alpha coefficients for the measures of school satisfaction, positive affect in school, and negative affect in school were 0.95, 0.88 and 0.84 respectively for the sample at Time 1, and 0.96, 0.91 and 0.87 respectively for the sample at Time 2.

2.2.2 *Basic Psychological Needs Satisfaction at School*

To measure the basic psychological needs satisfaction at school, we used the Adolescent Students' Basic Psychological Needs at School Scale (Tian et al. 2013a). It is a 15-item self-report scale comprised of three subscales: (a) Need for Autonomy (b) Need for Relatedness, and (c) Need for Competence. The need for autonomy refers to feeling a sense of volition and endorsement in students' behavior at school. It consists of five items (e.g., "I can decide for myself how to do things at school."). The need for relatedness refers to situations where students feel that they are authentically associated with teachers and classmates and experience a sense of school belonging. It consists of five items (e.g., "Teachers and classmates care about me at school"). The need for competence refers to students' needs to interact effectively with their school environment and to experience opportunities for expressing or developing their capacities. It consists of five items (e.g., "I am capable of learning new knowledge at school."). Responses were made on a 6-point scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). The internal consistency reliabilities of autonomy, relatedness, competence subscales have been reported as 0.85, 0.80, 0.77 respectively and the 5-week retest reliability coefficients were 0.73, 0.71, 0.74 respectively (Tian et al. 2013a). In this study, the alpha coefficients for the measures of autonomy, relatedness, competence were 0.80, 0.80, and 0.70 respectively for the sample at Time 1, and 0.86, 0.83, and 0.71 respectively for the sample at Time 2.

2.3 Procedure

After the study was approved by the school board, principals, and teachers, letters describing the study and consent forms were sent to the students' parents. Only children who brought back the consent form signed by a parent and who gave their own assent took part in the study.

Two surveys occurred 6 weeks apart. At Time 1 and Time 2, teachers administered surveys to groups of about 50 students in a regular classroom environment. Teachers read scripted directions instructing students that their responses would remain confidential, informing them of the right to withdraw from the study at any time, and asking them to complete all measures in the packet. Before completing study measures, students answered some demographic questions regarding age, grade level and gender.

2.4 Data Analysis

The data analysis plan followed three steps. First, preliminary analyses including attrition analysis, descriptive statistics, and correlations were conducted using the SPSS 16.0 statistical package (Norusis 2008). Specifically, χ^2 tests and analyses of variance (ANOVAs) were conducted to assess bias related to attrition between students who completed surveys at Time 1 only and students who completed surveys at Time 1 and Time 2. Descriptive statistics were calculated. Spearman correlations were performed to determine the zero-order relationships among the predictor and criterion variables with dichotomized demographic variables (e.g., gender, grade level). Pearson correlations were conducted to ascertain the associations between basic psychological needs satisfaction at school and school-related subjective well-being indicators. Second, confirmatory factor analysis using AMOS 7.0 statistical package (Arbuckle 2006) was performed to examine the factor structure of the instruments at Time 1 and Time 2. Finally, structural equation modeling (SEM) in AMOS was further used to examine the relationships between three psychological

needs satisfaction at school and school-related subjective well-being indicators at a 6-week follow-up. An alpha level of 0.05 was used for all tests of significance.

To test the hypotheses about the relationships between the specific basic psychological need satisfaction at school and school-related subjective well-being indicators at a 6-week follow-up, fully cross-lagged panel models were used. Additionally, to study the effects of the three needs satisfaction variables on the three school-related subjective well-being indicators separately, three series of recursive structural equation models were used, with three models in each series. In the first series, the subjective well-being variable was school satisfaction. In the second series, the subjective well-being variable was positive affect in school. In the third, it was negative affect in school. In the models for each series, we used item scores to form a latent variable, namely autonomy (model 1), relatedness (model 2), and competence (model 3). Strict measurement invariance was imposed and the error terms for each need and school-related subjective well-being indicator at Time 1 and Time 2 were allowed to covary. Effects of all Time 1 measures of each need and school-related subjective well-being indicator were modeled on Time 2 measures of autonomy, relatedness, competence, and school satisfaction, positive affect in school, and negative affect in school. Effects of covariates were modeled as paths from each covariate to all study factors. The models were thus saturated at the structural level. Controlled covariates in the model included gender (female = 1) and grade level (senior high school = 1).

The covariance matrix of the hypothesized model was analyzed using maximum likelihood estimation. Structural model fit was analyzed using multiple indicators. First, Chi square (χ^2) was considered. Traditionally, a good factor structure is inferred when the χ^2 likelihood ratio is non-significant. However, given the sensitivity of the χ^2 statistic to sample size (Jöreskog and Sörbom 1996; Saris 1982), we complemented this approach with other goodness-of-fit-measures. These measures were the non-normed fit index or Tucker Lewis index (TLI), the comparative fit index (CFI), and the root mean-square error of approximation (RMSEA). Based on simulated data (Hu and Bentler 1999) proposed that CFI and TLI measures should be close to or greater than 0.95 to indicate good fit. However, it should be noted that, other psychometric experts (e.g., Marsh 2002) consider these conventional fit criteria too restrictive when applied to complex models with multiple indicators, contending that such guidelines may be unrealistic in situations in which "real" data are tested rather than simulated. Marsh et al. (2004) and (Hou and Wen 2004) proposed that a CFI and TLI cutoff value greater than 0.90 indicate adequate fit. Therefore, we interpreted CFI and TLI values greater than 0.95 as indicating good fitting models, and greater than 0.90 as indicating acceptable and adequate fitting models. With regards to RMSEA, values less than 0.06 are typically considered indicative of good fit, while values between 0.06 and 0.10 are considered adequate fit (Kaplan 2000; Hu and Bentler 1999).

3 Results

3.1 Preliminary Analyses

3.1.1 Attrition Analysis

χ^2 tests on demographic variables were conducted to assess bias related to attrition between students who completed surveys at Time 1 only and students who completed surveys at Time 1 and Time 2. There was no association between administration time and gender (χ^2 (1) = 2.58, $p > 0.05$) or time and grade level (χ^2 (1) = 6.08, $p > 0.05$).

ANOVAs on needs satisfaction at school and school-related subjective well-being indicators were conducted to assess bias related to attrition between participants at Time 1 only and participants at Time 1 and Time 2. There were no differences in relatedness (F (1,653) = 0.08, $p > 0.05$), competence (F (1, 653) = 0.01, $p > 0.05$), school satisfaction (F (1, 653) = 0.02, $p > 0.05$), positive affect (F (1, 653) = 0.52, $p > 0.05$), or negative affect (F (1, 653) = 0.17, $p > 0.05$) for Time 1 and Time 2 samples. Students who only participated at Time 1 had higher autonomy (F (1, 653) = 19.84, $p < 0.01$, $\eta^2 = 0.03$). However, the effect is considered small (Cohen 1988).

3.1.2 Descriptive Statistics

The means and standard deviations for Time 1 and Time 2 psychological needs satisfaction at school and school-related subjective well-being indicators are presented in Table 1.

For each variable, higher scores indicate higher levels of that psychological construct. Participants mildly to moderately agreed to being satisfied with their school lives (T1 $M = 4.35$, $SD = 0.69$; T2 $M = 4.31$, $SD = 0.73$) and experienced a higher frequency of positive affect (T1 $M = 4.11$, $SD = 0.83$; T2 $M = 4.18$, $SD = 0.85$) and a lower frequency of negative affect (T1 $M = 3.50$, $SD = 0.79$; T2 $M = 3.45$, $SD = 0.83$), which was similar to levels reported by previous research with middle school students (Tian 2008). Students "moderately agree" that school can satisfy their need for relatedness (T1 $M = 4.75$, $SD = 0.73$; T2 $M = 4.63$, $SD = 0.74$), but they "mildly agree" that school can satisfy their needs for autonomy (T1 $M = 3.79$, $SD = 0.98$; T2 $M = 3.90$, $SD = 1.01$) and competence (T1 $M = 4.04$, $SD = 0.83$; T2 $M = 4.07$, $SD = 0.79$). In order to assess univariate normality, skewness and kurtosis were examined for all variables. The values of skewness and kurtosis fall within the acceptable range of -1 to 1 (Tabachnick et al. 2001), thus there was non-significant non-normality in the data.

3.1.3 Correlation Analysis

Spearman rho correlations among dichotomized demographic variables (e.g., gender, grade level) and the predictor and criterion variables are found in Table 2. Gender was coded 0 for male and 1 for female. Grade level was coded 0 for junior high school and 1 for senior high school. At both Time 1 and Time 2, gender was significantly correlated with negative affect in that females reported higher frequencies of negative affect compared to males ($r = 0.09$, $p < 0.05$ at Time 1 and $r = 0.15$, $p < 0.01$ at Time 2). At Time 2, gender was significantly correlated with competence in that females reported lower levels of competence than males ($r = -0.08$, $p < 0.05$). At both Time 1 and Time 2, student grade level was significantly correlated with autonomy, negative affect, and school satisfaction in that the senior high school students reported higher levels of autonomy, negative affect ($r = 0.10$, $p < 0.05$; $r = 0.28$, $p < 0.01$, respectively at Time 1 and $r = 0.12$, $p < 0.01$; $r = 0.17$, $p < 0.01$, respectively at Time 2), and lower levels of school satisfaction than junior high school students ($r = -0.28$, $p < 0.01$ at Time 1; $r = -0.12$, $p < 0.01$ at Time 2). At Time 1, but not Time 2, student grade level was significantly correlated with competence and positive affect in that the senior high school students reported lower levels of competence and positive affect ($r = -0.17$, $p < 0.01$; $r = -0.15$, $p < 0.01$, respectively). Because of these relationships, the two demographic variables were included as covariates in the model of bi-directional relationships between the three basic psychological needs satisfaction at school and school-related subjective well-being variables.

Table 1 Descriptive statistics

Variable	Time 1				Time 2			
	M	SD	Skewness	Kurtosis	M	SD	Skewness	Kurtosis
Autonomy	3.79	0.98	−0.27	−0.21	3.90	1.01	−0.28	−0.08
Relatedness	4.75	0.73	−0.59	0.60	4.63	0.74	−0.55	0.73
Competence	4.04	0.83	−0.24	0.27	4.07	0.79	−0.17	0.32
School satisfaction	4.35	0.69	−0.06	−0.12	4.31	0.73	−0.06	−0.20
Positive affect in school	4.11	0.83	−0.28	0.74	4.18	0.85	−0.36	0.78
Negative affect in school	3.50	0.79	−0.10	0.11	3.45	0.83	−0.17	0.23

$N = 576$; Autonomy = the need for autonomy at school; Relatedness = the need for relatedness at school; Competence = the need for competence at school

Pearson correlations among Time 1 and Time 2 basic psychological needs satisfaction at school and school-related subjective well-being indicators are shown in Table 2. Significant modest to moderate correlations were found among the three basic psychological needs satisfaction at school and three school-related subjective well-being indicators at Time 1 and Time 2. Also, positive correlations among the three basic psychological needs satisfaction were moderate at both Time 1 and Time 2. It might be argued that since the three needs tend to be moderately correlated with each other, which potentially introduces the problem of multicollinearity, it is necessary to study a (possible) combined effect, and redundant to search for the most important need predicting school-related subjective well-being. Although this argument has merit, it is essential to highlight that these correlations are not higher than 0.64. Moreover, a principal component analysis with promax rotation was performed and three factors with eigenvalues higher than 1 (4.69, 1.90 and 1.43) were retained, explaining 53 % of the variance. Furthermore, the data were analyzed using Structural Equation Modeling (SEM) in order to control measurement error and collinearity among variables (Garcia and Moradi 2012; Malhotra et al. 1999; Verbeke and Bagozzi 2000, p. 93). Finally, it would be pointed out that the good reliabilities of the three need subscales and a large sample size ($N = 576$) can effectively protect against the deleterious effects of multicollinearity (Grewal et al. 2004). School satisfaction and positive affect were moderately positively correlated at both Time 1 and Time 2, and negative affect was moderately negatively correlated with positive affect and school satisfaction at both Time 1 and Time 2. Additionally, relatedness, autonomy, competence, negative affect, positive affect, and school satisfaction were moderately stable from Time 1 to Time 2 ($r = 0.49$ to 0.69, respectively).

3.2 Confirmatory Factor Analysis

3.2.1 Basic Psychological Needs Satisfaction at School

At Time 1, the χ^2 test and the fit indexes were χ^2 (576, 87) = 220.10 ($p < 0.001$), CFI = 0.95, TLI = 0.93, and RMSEA = 0.05. At Time 2, the χ^2 test and the fit indexes were χ^2 (576, 87) = 230.03 ($p < 0.001$), CFI = 0.96, TLI = 0.95, and RMSEA = 0.05. Factor loadings were between 0.41 and 0.76, and between 0.40 and 0.81 at Time 1 and Time 2, respectively.

Table 2 Time 1 and Time 2 correlations among demographics and basic psychological needs satisfaction at school and school-related subjective well-being

Variable	AU1	RE1	CO1	SS1	PA1	NA1	AU2	RE2	CO2	SS2	PA2	NA2
AU1	1											
RE1	0.46**	1										
CO1	0.42**	0.56**	1									
SS1	0.49**	0.63**	0.58**	1								
PA1	0.36**	0.43**	0.50**	0.54**	1							
NA1	−0.30**	−0.37**	−0.42**	−0.51**	−0.44**	1						
AU2	0.53**	0.31**	0.32**	0.41**	0.29**	−0.21**	1					
RE2	0.31**	0.49**	0.34**	0.48**	0.30**	−0.24**	0.54**	1				
CO2	0.33**	0.38**	0.52**	0.50**	0.42**	−0.30**	0.56**	0.64**	1			
SS2	0.40**	0.50**	0.48**	0.69**	0.38**	−0.39**	0.61**	0.68**	0.61**	1		
PA2	0.29**	0.38**	0.42**	0.48**	0.55**	−0.40**	0.48**	0.50**	0.58**	0.62**	1	
NA2	−0.16**	−0.23**	−0.31**	−0.33**	−0.29**	0.52**	−0.27**	−0.27**	−0.38**	−0.42**	−0.46**	1
Gender	−0.02	0.07	−0.03	0.05	0.03	0.09*	−0.04	0.01	−0.08*	0.02	−0.06	0.15**
Grade level	0.10*	−0.08	−0.17**	−0.28**	−0.15**	0.28**	0.12**	−0.04	−0.03	−0.12**	−0.05	0.17**

AU = the need for autonomy at school; RE = the need for relatedness at school; CO = the need for competence; SS = school satisfaction; PA = positive affect in school; NA = negative affect in school; 1 = Time 1; 2 = Time 2. Gender is coded 0 = male and 1 = female; Grade level is coded 0 = junior high school and 1 = senior high school

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2.2 School-Related Subjective Well-Being

The initial model indicated that two school satisfaction items (S 2 and S 6), two positive affect in school items (PA 3 and PA 4), and two negative affect in school items (NA 5 and NA 6) were more correlated than expected at Time 1 and Time 2, respectively, possibly due to semantically similar wording. In the subsequent confirmatory factor analyses and final analyses, the residuals of these three paired items were allowed to covary in order to improve model fit. At Time 1, the χ^2 test and the fit indexes were χ^2 (576, 164) = 621.37 ($p < 0.001$), CFI = 0.93, TLI = 0.92, and RMSEA = 0.07. At Time 2, the χ^2 test and the fit indexes were χ^2 (576, 164) = 757.55 ($p < 0.001$), CFI = 0.92, TLI = 0.91, and RMSEA = 0.08. Factor loadings were between 0.43 and 0.81, and between 0.53 and 0.88 at Time 1 and Time 2, respectively.

3.3 Structural Equation Modeling

As seen in Table 3, in all models, each of the three basic psychological needs satisfaction at school and school-related subjective well-being indicators at Time 1 showed a positive and significant effect on the same latent variable at Time 2.

The first hypothesis that all of the three basic psychological needs at school at Time 1 would predict changes in Time 2 school-related subjective well-being indicators was partially supported. When controlling for covariates and Time 1 level of school-related subjective well-being in the models in which autonomy was used at Time 1, Time 1 autonomy only significantly predicted Time 2 school satisfaction ($\beta = 0.10$, $p < 0.05$), whereas no significant effect emerged for positive affect or negative affect in school ($\beta = 0.08$, $p > 0.05$; $\beta = 0.00$, $p > 0.05$, respectively). In the models in which relatedness was used at Time 1, Time 1 relatedness also only significantly predicted Time 2 school satisfaction ($\beta = 0.08$, $p < 0.05$); no significant effect emerged for positive affect or negative affect ($\beta = 0.08$, $p > 0.05$; $\beta = -0.04$, $p > 0.05$, respectively). In the models in which competence was used at Time 1, Time 1 competence significantly predicted all Time 2 indicators of school-related subjective well-being ($\beta = 0.12$, $p < 0.05$; $\beta = 0.24$, $p < 0.001$; $\beta = -0.11$, $p < 0.05$, respectively).

The second hypothesis that Time 1 school-related subjective well-being indicators would predict changes in all of the three basic psychological needs at school at Time 2 was also partially supported. When controlling for covariates and Time 1 autonomy, in the models in which autonomy was used at Time 1, only school satisfaction was found to be a significant predictor of the need for autonomy ($\beta = 0.21$, $p < 0.001$); positive and negative affect in school were not predictors ($\beta = 0.06$, $p > 0.05$; $\beta = -0.06$, $p > 0.05$, respectively). In the models in which relatedness was used at Time 1, when controlling for covariates and Time 1 relatedness, school satisfaction and positive affect in school were significant predictors of the need for relatedness ($\beta = 0.20$, $p < 0.001$; $\beta = 0.10$, $p < 0.05$, respectively), whereas negative affect was not a predictor ($\beta = -0.04$, $p > 0.05$). In the models in which competence was used at Time 1, when controlling for covariates and Time 1 competence, school satisfaction and positive affect in school were also found to be significant predictors of the need for competence ($\beta = 0.38$, $p < 0.001$; $\beta = 0.15$, $p < 0.01$, respectively), whereas negative affect was not a predictor ($\beta = -0.09$, $p > 0.05$).

Thus, bidirectionality between the three basic psychological needs satisfaction at school and school-related subjective well-being indicators was supported for school satisfaction and positive affect in school, but not for negative affect in school. Regarding the fit indexes

Table 3 χ^2 value, fit indexes and standardized path coefficients in the models

Model	χ^2	*df*	*p*	TLI	CFI	RMSEA	T1 BPNS- T2 BPNS	T1 SRSWB- T2 SRSWB	T1 BPNS- T2 SRSWB	T1 SRSWB- T2 BPNS
Model 1 autonomy										
SS	855.15	236	0.00	0.92	0.93	0.07	0.48***	0.66***	0.10*	0.21***
PA	531.27	283	0.00	0.96	0.97	0.04	0.58***	0.56***	0.08	0.06
NA	534.31	283	0.00	0.95	0.96	0.04	0.59***	0.56***	0.00	−0.06
Model 2 relatedness										
SS	898.20	236	0.00	0.91	0.92	0.07	0.46***	0.68***	0.08*	0.20***
PA	588.48	283	0.00	0.95	0.96	0.04	0.52***	0.57***	0.08	0.10*
NA	647.95	283	0.00	0.93	0.94	0.05	0.56***	0.54***	−0.04	−0.04
Model 3 competence										
SS	1,056.23	236	0.00	0.90	0.91	0.08	0.36***	0.64***	0.12*	0.38***
PA	749.88	283	0.00	0.92	0.93	0.05	0.53***	0.46***	0.24***	0.15**
NA	644.01	283	0.00	0.92	0.93	0.05	0.57***	0.50***	−0.11*	−0.09

Autonomy = the need for autonomy at school; Relatedness = the need for relatedness at school; Competence = the need for competence at school. SS = school satisfaction; PA = positive affect in school; NA = negative affect in school; BPNS = basic psychological need satisfaction; SRSWB = school-related subjective well-being indicator; T1 = Time 1; T2 = Time 2

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

of all the models, although the value χ^2 was significant in all models, the various fit indexes showed acceptable values. All models were over identified.

4 Discussion

The first hypothesis that all of the basic psychological needs satisfaction variables at school would predict changes in Time 2 school-related subjective well-being indicators was partially supported. Specifically, Time 1 autonomy and relatedness predicted changes in Time 2 school satisfaction, also, Time 1 competence predicted changes in Time 2 for all indicators of school-related subjective well-being. Thus, adolescent students who experienced higher levels of needs satisfaction at the beginning of the school year reported subsequent higher levels of school-related subjective well-being, even after controlling for grade level and gender. In line with SDT (Ryan and Deci 2000), the findings demonstrate that each need satisfaction at school predicted the school-related subjective well-being of adolescents, who represent an under-investigated age group in the SDT tradition. Moreover, competence was the most significant predictor of school-related subjective well-being because it was the only predictor that predicted all of the school-related subjective well-being indicators. Similar findings have been found in other important domains in the lives of children and adolescents. For example, Véronneau et al. (2005) suggested that competence is the most important psychological need in middle childhood and early adolescence. During adolescence, individuals face many biological, cognitive, and social challenges (Bandura 1997; Graber et al. 1996). In social-cognitive theory, youngsters who have a high sense of personal efficacy in key life domains such as academic performance and social interactions are more likely to face challenges in a persevering and relatively anxiety-free manner (Bandura 1997). Therefore, adolescents' needs for competence may be the most salient need to satisfy to promote successful adaptation. Interestingly, competence was the only need that was significantly associated with negative affect in school. This finding may help explain why female adolescents, who report lower levels of competence compared to males, are more vulnerable to negative affect. This finding may also explain why senior high school students, who report lower levels of competence than junior high school students, are more vulnerable to negative affect and low levels of school satisfaction and positive affect in school. In addition, although the contribution to well-being was smaller than that of competence satisfaction, satisfaction of relatedness and autonomy needs also appears crucial for maintaining adolescents' school satisfaction in the Chinese cultural context. This finding is consistent with SDT (Ryan and Deci 2000) in that competence, relatedness, and autonomy are essential needs for psychological growth and well-being regardless of cultural backgrounds or values.

The second hypothesis that Time 1 school-related subjective well-being indicators would predict changes in all three basic psychological needs in school at Time 2 was also partially supported. Specifically, Time 1 school satisfaction predicted changes in all three Time 2 needs satisfaction variables at school. Time 1 positive affect predicted changes in Time 2 relatedness and competence satisfaction at school. Thus, adolescents who were initially satisfied with their school lives felt more connected, confident and autonomous six weeks later, even after controlling for demographic variables. The finding is consistent with previous research which suggests that students who are happy with school are more likely to emit prosocial behaviors in the classroom, such as treating teachers and classmates respectfully and working cooperatively with others (Parish and Parish 2005) as well earning higher grades (Huebner and Gilman 2006). This finding is also consist with the

Broaden-and-Build Theory of positive emotion (Fredrickson 2001) in that persons experiencing positive emotions show patterns of thought that are notably unusual (Isen et al. 1985), flexible (Isen and Daubman 1984), creative (Isen et al. 1987), open to new information (Estrada et al. 1997), efficient (Isen et al. 1991), and accepting of variety and a broader array of behavioral options (Kahn and Isen 1993). However, Time 1 negative affect did not predict changes in Time 2 basic psychological needs satisfaction, this finding supports the notion of Broaden-and-Build that positive affect and negative affect are differentiable constructs with differential functions (Fredrickson 2001).

Support was demonstrated for a bidirectional relationship between autonomy, relatedness, and competence needs satisfaction at school and school satisfaction, competence need satisfaction at school and positive affect in school. Students who reported higher levels of needs satisfaction were more satisfied with their school lives and experienced more positive affect in school, which in turn increased their ability to perceive many ways in which their school can satisfy their needs for competence, relatedness, and autonomy. This broadened thinking may lead to the further building of academic and social resources in an upward spiral over time.

The bidirectional link between needs satisfaction at school and school-related subjective well-being suggests a possible causal role for needs satisfaction at school in determining individual differences in school-related subjective well-being, as well as vice versa. This study is one of the few studies to investigate the role of individual differences, such as needs satisfaction, in explaining school-related subjective well-being. This finding may thus inform academic and health promotion efforts because needs satisfaction can be altered through interventions, unlike personality/temperament variables that are more resistant to interventions (Lyubomirsky King et al. 2005; Lyubomirsky, Sheldon et al. 2005; Sin and Lyubomirsky 2009). The bidirectional relationship between basic psychological needs satisfaction at school and school-related subjective well-being also underscores the importance of school-related subjective well-being to adolescents. This research supports Noddings' (2003) contention that children's happiness should be a major aim of their schooling (p. 1). The present study suggests that adolescents' subjective well-being in school is not just a by-product of doing well in school but also may contribute to positive adaptive outcomes such as obtaining need satisfaction, particularly the needs for competence.

This study has implications for school professionals in understanding the relationship between basic psychological needs satisfaction at school and school-related subjective well-being in adolescents. The finding of bidirectionality between basic psychological needs satisfaction at school and school-related subjective well-being also has important implications for school professionals' intervention efforts. Support for models in which basic psychological needs satisfaction at school is theorized to cause individual differences in school-related subjective well-being would suggest that professionals should focus their efforts exclusively on creating positive school environments that satisfy students' basic psychological needs satisfaction at school, particularly with the conditions supportive of positive student perceptions of competence, and that such efforts will result in increased school-related subjective well-being. Support for models in which the effects are in the opposite direction, that is, where school-related subjective well-being is theorized to cause differences in basic psychological needs satisfaction at school, would result in differing implications. The latter model would suggest that professionals should exert exclusive efforts toward improving school-related subjective well-being, particularly with school satisfaction, in order to promote greater basic psychological needs satisfaction at school. In contrast to such simplistic models, a bidirectional model implies that basic psychological

needs satisfaction at school and school-related subjective well-being are reciprocally related and mutually reinforcing. Greater basic psychological needs satisfaction at school will lead to increased school-related subjective well-being, and increased school-related subjective well-being will result in greater basic psychological needs satisfaction. To best tailor these interventions, more needs to be known about the underlying processes that connect these two domains. The social, cognitive, or other underlying mechanisms that could potentially account for the relation between needs satisfaction and school-related subjective well-being remain unspecified by this study. The data that were collected for this study allowed us to successfully model the direction of influence between these two domains and answered questions of directionality, but not questions of process. Toward this aim, some researchers proposed that autonomous motivation and school engagement might be the mechanisms linking these two domains (Connell and Wellborn 1991; Ryan and Deci 2000). More research on these mechanisms would be worthwhile and would illuminate the processes by which basic psychological needs satisfaction influences school-related subjective well-being (and vice versa). A major implication of our findings is that both basic psychological needs satisfaction and school-related subjective well-being need to be recognized as important contributors to adolescents' success in school settings.

This study has some strengths and limitations that should be noted. First, more information is provided about the nature and directionality of the relationship between basic psychological needs satisfaction at school and school-related subjective well-being beyond that of cross-sectional studies, since two waves of data were collected and analyzed. However, future research should also include three or more waves of data in order to more comprehensively assess basic psychological needs satisfaction at school and school-related subjective well-being connections. Second, although the finding of bidirectionality between basic psychological needs satisfaction at school and school-related subjective well-being is important for school professionals, the psychosocial mechanisms accounting for the relationships between these two domains remain unclear; future studies should examine these relationships with additional explanatory variables. Third, although SDT posits that the three needs are universal, this study concentrated on adolescents' needs satisfaction in a sample of students from China. Future studies in different nations are needed to assess the generalizability of the findings. Finally, all data were based on students' self-report. Although many studies have demonstrated the validity of adolescents' self-report measures (Dew and Huebner 1994; Gilligan and Huebner 2002), multiple methods of assessment would enhance confidence in the validity of the data.

5 Conclusions

In summary, the present study supports assumption of SDT that the satisfaction of needs for autonomy, competence, and relatedness contributes to human well-being, and it extends its applicability to younger populations and school. This study revealed that each of the basic psychological needs at school is central to school-related subjective well-being, with each need at school contributing unique variance to adolescents' school well-being. Satisfaction of competence need seems to be a particularly strong predictor of adolescents' school-related subjective well-being over time. This finding supports the notion that subjective well-being and competence should both be critical aims of education (Noddings 2003). Furthermore, this study is one of the few studies to explore the directionality of these two sets of variables in a cross-lagged design in the context education. Finally, it extends beyond cross-sectional studies by showing that autonomy, relatedness, and

competence needs satisfaction at school and school satisfaction, competence need satisfaction at school and positive affect in school are reciprocally related over time. The findings not only add to the existing literature on SDT and school-related subjective well-being, but also provide additional evidence that basic psychological needs satisfaction and subjective well-being are important in and of themselves in adolescents' educational experiences.

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